SOIL GAS SURVEY OF THE FERRON SANDSTONE MEMBER OF THE MANCOS SHALE, NORTHERN EMERY COUNTY, UTAH

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ABSTRACT
A soil gas survey was performed to determine the presence and concentration of methane along a portion of the Ferron Sandstone Member of the Mancos Shale outcrop. The outcrop surveyed is adjacent to the proposed Ferron Natural Gas Project South Area. Procedures and equipment utilized ensure repeatability, allowing for future trend analysis. This study concludes methane is not currently present or escaping from this portion of outcrop.

INTRODUCTION
During the scoping process for the Ferron Natural Gas Environmental Impact Statement (FNG EIS) issues were raised about the possibility of methane gas at the surface. Gas released at the surface could potentially affect the health and safety of residents and/or wildlife of the area.

The proposed Ferron Natural Gas project involves extracting natural gas from both sandstone and coal intervals in the Ferron Sandstone Member of the Mancos Shale (Ferron Sandstone). To extract gas from coal intervals, water must first be removed or pumped out. As water is pumped out, gas is released from the coalbeds. This gas is refered to as coalbed methane (CBM). Gas then flows to the wellbore or areas of low pressure. The concern is that gas will also migrate updip in the Ferron Sandstone to the outcrop and then be released at the surface.

To address the lack of baseline data, public and agency concerns, and potentially serious impacts from the CBM production, it was determined that a soil gas survey was necessary.

PROCEDURE
Equipment and procedures were designed to ascertain the gross presence of methane, and provide a means for future repeatability and trend analysis if necessary. A methodology for initial baseline studies was established based upon soil gas studies performed in other CBM areas (especially the San Juan Basin, Colorado and New Mexico). This involved an inital review of infra-red aerial photos followed by a field inventory.

<u>Infra-Red Aerial Photo Review</u>
Infra-red aerial photos (1974) are available for most of the survey area. These color enhanced photos show vegetation in red. Gross variations in surface temperature may also be detected in this type of photograph.

Vegetation loss or anomalous lack of vegetation may identify methane seeps. Unusual variations in surface temperature may indicate near- surface combustion of methane.

The study area, as well as the surrounding areas, is sparsely vegetated due to poor soil characteristics. Therefore, potential methane seeps could not be identified using this procedure. No unusual surface temperatures were noted on the photos, indicating no sub-surface combustion was occurring.

Field Inventory

The field inventory was conducted October 20-21, 1997, on a 25 mile section of the Ferron Sandstone outcrop. All accessible sites with Ferron Sandstone outcrop adjacent to the FNG EIS South Area were included in the survey. Figure #1 shows the location of the sample sites. The Ferron Sandstone is not exposed adjacent to the North Area of the FNG EIS.

A total of 70 sites were sampled, approximately 400 meters apart. Sample sites are numbered sequentially, starting with #1 located at the NE corner. Each site was precisely located with a global positioning system unit, and permanently marked on the ground.

Sites with no outcrop were not sampled. The survey crossed several large washes and low spots where the outcrop was covered with alluvium. The silty sandstone facies of the Ferron Sandstone pinched out to the south. Another area not sampled is the Hunter power plant facility, due to lack of access.

In addition to sampling the lower explosive level of methane (LEL CH_4), concentrations of methane (CH_4), carbon monoxide (CO), hydrogen sulfide (H_2S), and oxygen (O_2) were recorded for each site. Carbon monoxide is a by-product of methane combustion. Hydrogen sulfide is a gas which may be found in concert with methane.

Other information recorded for each site included general surface characteristic (alluvium, bedrock, rubble, soil), slope (cliff, flat, hillside, hilltop), whether any residences were within one mile, and pertinent GPS data. Attachments #1 and #2 list this data for each sample site.

Equipment Used:

An Industrial Scientific TMX 412 Multi-Gas Monitor was equipped with a gas pump, tubing and an inverted funnel to obtain a sample directly from the outcrop. This monitor provides repeatable measurements in a field-ready unit.

Prior to field use, the monitor was calibrated. A methane standard was utilized to ensure that the monitor was in operating condition and properly calibrated. This operational test was performed twice daily after oxygen sensor zeroing, prior to use in both the morning and afternoon data collection periods.

The position of the site was located using a resource-grade Global Positioning Survey (GPS) unit (accuracy of ±5 meters). Gas Monitor data, along with general surface characterization remarks, were entered into the GPS unit, as well as recorded manually in a logbook. The sites were staked with rebar, marked with orange paint, and uniquely identified for reference and possible future trend analysis.

DATA RESULTS

Neither methane, carbon monoxide, nor hydrogen sulfide was detected at any of the sample sites. Oxygen was detected at average levels for this elevation, with normal diurnal fluctuations.

RELATED STUDIES

The U.S. Geological Survey is conducting an ongoing survey of gases in soil as well as shallow ground water in the area of current and proposed CBM development near Price, Utah (USGS, 1998). The majority of samples are located several miles west of the Ferron Sandstone outcrop.

A total of 121 samples at 96 sites have been taken since 1995. The average methane concentration has been less than 0.005 mg/L (the detection limit). The two highest concentrations occurred within 30' of active wells. Samples taken within 50' of the same wells showed no detectable methane. These sites were resampled at a later date, with no detectable methane levels at either distance from the wells.

The U.S. Geological Survey is also involved in developing a regional fluid flow model in relationship to methane production for the Ferron Sandstone. No information from this study has yet been released.

COMPARISIONS WITH SAN JUAN BASIN CBM PROJECTS

Coalbed methane production in the San Juan Basin, Colorado/ New Mexico (near Durango, Colorado) may have increased the amount of methane seeping to the surface, creating problems with water quality, loss of vegetation, fire hazards, etc. This has caused some concern about the FNG project.

The geologic setting and water sources in the San Juan Basin differ significantly from the setting in the FNG EIS area. There is little potential for similar problems to occur locally. These differences are discussed briefly below.

<u>San Juan Basin</u>

There is a documented history of gas seeps throughout the San Juan Basin. There is no true caprock above the gas producing horizons. Coalbeds and other gas producing intervals are exposed at the surface near residences. There is a constant natural flow of water through the gas producing zones up to the surface (Quinn). Sources of residential water and springs are the same rock units that are producing gas.

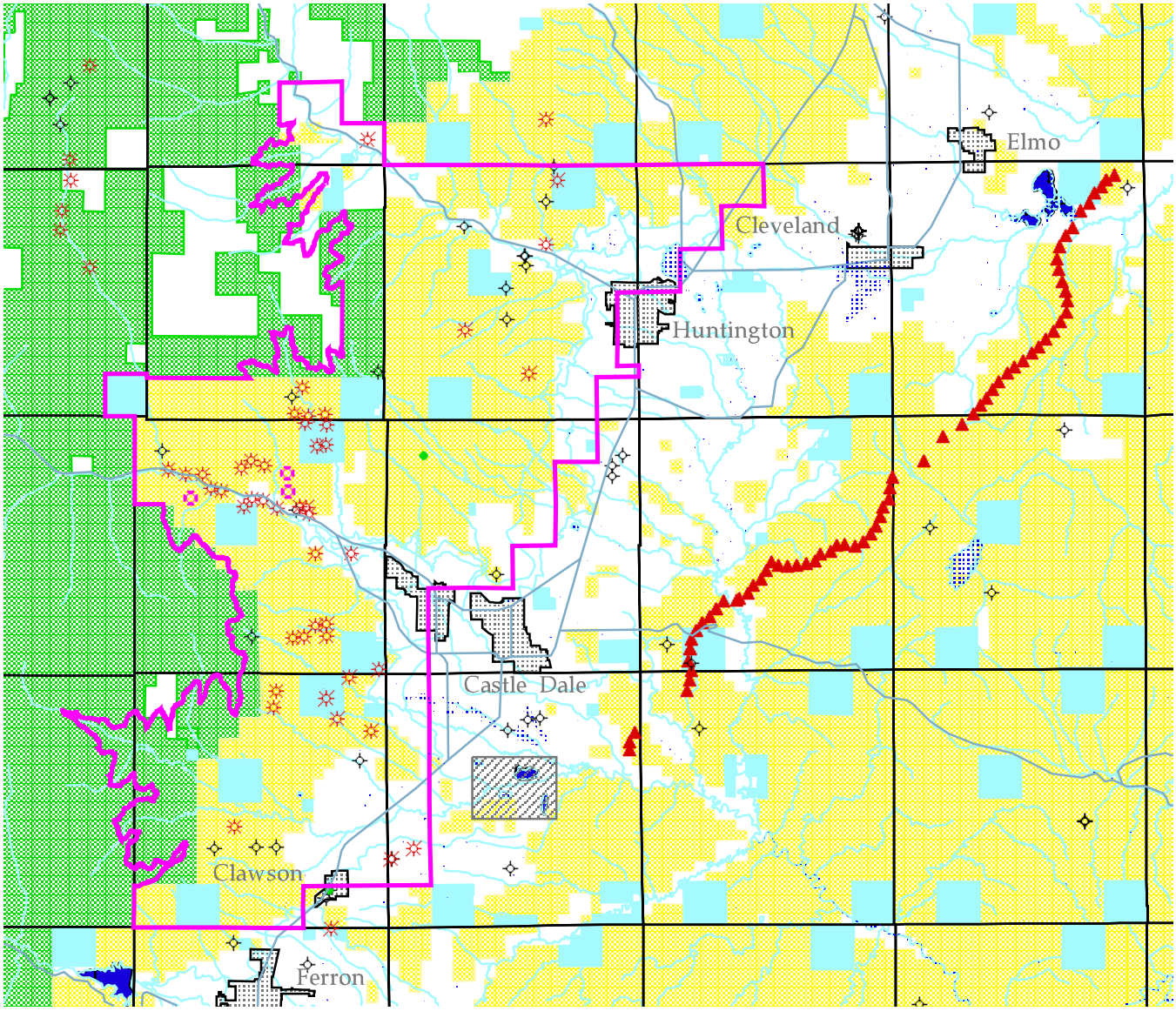
FNG EIS Area

In the FNG EIS area, there are no known gas seeps. There is a substantial caprock (+/- 2000' of impermeable Mancos Shale) between the surface and the gas producing zone. Ferron coalbeds pinchout several miles west of the outcrop in this area, and are not exposed at the surface.

CONCLUSIONS

The survey data indicates methane, carbon monoxide and hydrogen sulfide are not currently escaping along the Ferron outcrop. Near-surface combustion is not occurring along or near the outcrop. Due to different geologic settings and water sources, the problems of the San Juan Basin should not occur in the FNG EIS area.

SAMPLE SITE LOCATIONS



Legend

- Gas Well (producing or shut in)
- Oil Well (producing or shut in)
- Plugged Well
- Drilling Shut In Well
- BLM
- US Forest Service
- Private
- State
- Sample Site
- FNG EIS South Area Boundary
- Towns
- Hunter Power Plant Facilities

FIGURE #1

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4-8-98

REFERENCES

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Lines, G.C., Morrissey, D.J., 1983, Hydrology of the Ferron Sandstone aquifer and effects of proposed surface coal mining in Castle Valley, Utah, USGS Water Supply Paper 2195

Naftz, D.L., Hadley, H.K., Hunt, G.L. 1998, Determination of methane concentrations in shallow ground water and soil gas near Price, Utah, U.S. Geological Survey Fact Sheet FS-191-97, 4 p.

Quinn, J.C., Marinello, S.A., 1994, Desorption of methane from coal stringers in shallow aquifer regimes *in* 1994 Rocky Mountains Symposium on environmental issues in oil and gas operations, soft footprints for the '90s, Colorado School of Mines & U.S. Bureau of Land Management.

ATTACHMENT #1

Site_id	Ch4_%	Co_ppm	H2s_ppm	O2_%	Sfc_char	Slope	Remarks
1	0.00	0	0	21.00	RUBBLE	FLAT	
2	0.10	0	0	20.90	RUBBLE	HILLSIDE	CH4 -0.1 ?
3	0.00	0	0	21.00	RUBBLE	FLAT	50 FT NORTH OF FENCE LINE
4	0.00	0	0	21.00	RUBBLE	FLAT	ANTHILL
5	0.00	0	0	21.00	RUBBLE	FLAT	LAST SITE OF FILE
6	0.00	0	0	21.00	RUBBLE	FLAT	ADDITION TO MONDAYAM FILE
1	0.00	0	0	21.10	BEDROCK	FLAT	50 FEET SOUTHEAST OF ROAD
7	0.00	0	0	21.00	RUBBLE	HILLTOP	CHECK SEQUENCE
8	0.00	0	0	21.00	RUBBLE	HILLSIDE	SEC CRNR
9	0.00	0	0	21.00	RUBBLE	HILLTOP	SKUNK
10	0.00	0	0	21.00	RUBBLE	FLAT	
11	0.00	0	0	21.10	RUBBLE	HILLSIDE	
12	0.00	0	0	21.00	ALLUVIUM	FLAT	
13	0.00	0	0	21.10	RUBBLE	HILLTOP	
14	0.00	0	0	21.00	RUBBLE	HILLTOP	
15	0.00	0	0	21.00	RUBBLE	CLIFF	
16	0.00	0	0	21.10	RUBBLE	CLIFF	
17	0.00	0	0	21.00	RUBBLE	HILLSIDE	
18	0.00	0	0	21.00	RUBBLE	FLAT	
19	0.00	0	0	21.00	RUBBLE	FLAT	
20	0.00	0	0	21.00	RUBBLE	FLAT	
21	0.00	0	0	21.00	RUBBLE	HILLSIDE	
22	0.00	0	0	21.00	RUBBLE	FLAT	
23	0.00	0	0	21.10	RUBBLE	FLAT	
24	0.00	0	0	21.00	SOIL	FLAT	
25	0.00	0	0	21.10	RUBBLE	HILLTOP	
26	0.00	0	0	21.00	RUBBLE	FLAT	
27	0.00	0	0	21.10	SOIL	FLAT	
28	0.00	0	0	21.00	SOIL	FLAT	NO OUTCROP
29	0.00	0	0	21.00	RUBBLE	HILLTOP	FENCE LINE/ANTELOPE
30	0.00	0	0	21.10	SOIL	FLAT	
31	0.00	0	0	21.00	RUBBLE	FLAT	
32	0.00	0	0	21.00	RUBBLE	HILLSIDE	NO OUTCROP
33	0.00	0	0	21.00	RUBBLE	HILLTOP	
34	0.00	0	0	21.00	RUBBLE	HILLSIDE	
35	0.00	0	0	21.00	RUBBLE	HILLSIDE	
36	0.00	0	0	21.00	RUBBLE	FLAT	
37	0.00	0	0	21.00	RUBBLE	HILLTOP	
38	0.00	0	0	21.00	RUBBLE	HILLTOP	
39	0.00	0	0	21.00	RUBBLE	FLAT	
40	0.00	0	0	21.00	BEDROCK	HILLSIDE	
41	0.00	0	0	21.00	RUBBLE	HILLSIDE	
42	0.00	0	0	21.00	RUBBLE	HILLSIDE	
43	0.00	0	0	20.90	RUBBLE	HILLSIDE	
44	0.00	0	0	20.90	RUBBLE	HILLSIDE	
45	0.00	0	0	20.90	RUBBLE	HILLSIDE	
46	0.00	0	0	20.60	RUBBLE	HILLSIDE	TOPO BREAK
47	0.00	0	0	20.50	RUBBLE	HILLSIDE	
48	0.00	0	0	20.50	RUBBLE	HILLSIDE	
49	0.00	0	0	20.50	RUBBLE	HILLSIDE	
50	0.00	0	0	21.00	RUBBLE	HILLTOP	POWER LINE
51	0.00	0	0	21.00	RUBBLE	HILLTOP	
52	0.00	0	0	21.00	RUBBLE	HILLTOP	
53	0.00	0	0	21.00	RUBBLE	HILLTOP	BUCKHORN MARKER

Site_id	Ch4_%	Co_ppm	H2s_ppm	O2_%	Sfc_char	Slope	Remarks
54	0.00	0	0	21.00	RUBBLE	HILLTOP	
55	0.00	0	0	21.00	RUBBLE	HILLTOP	
56	0.00	0	0	21.10	RUBBLE	CLIFF	
57	0.00	0	0	21.00	RUBBLE	HILLTOP	TOPO CHANGE
58	0.00	0	0	21.00	RUBBLE	HILLSIDE	
59	0.00	0	0	21.00	RUBBLE	HILLTOP	
60	0.00	0	0	21.10	RUBBLE	HILLTOP	
61	0.00	0	0	21.10	RUBBLE	CLIFF	
62	0.00	0	0	21.10	RUBBLE	HILLTOP	
63	0.00	0	0	21.10	RUBBLE	HILLSIDE	
64	0.00	0	0	21.10	RUBBLE	HILLTOP	VALET PARKING
65	0.00	0	0	21.10	RUBBLE	HILLTOP	
66	0.00	0	0	21.10	RUBBLE	HILLSIDE	
67	0.00	0	0	21.10	RUBBLE	HILLSIDE	
68	0.00	0	0	21.10	RUBBLE	HILLSIDE	
69	0.00	0	0	21.00	RUBBLE	HILLSIDE	

ATTACHMENT #2

Site_id	Date	Max_pdop	Filt_pos	Std_dev	Gps_height
1	19971020	2.3	65	0.139018	5676.677
2	19971020	2.5	162	0.185023	5670.106
3	19971020	2.3	188	0.270666	5652.046
4	19971020	2.6	65	0.678250	5644.271
5	19971020	1.8	118	0.086538	5625.147
6	19971020	2.1	104	0.250640	5605.532
1	19971020	2.7	72	0.407415	5617.932
7	19971020	2.5	35	0.094747	5653.440
8	19971020	2.4	77	0.293280	5662.278
9	19971020	2.2	83	0.118732	5712.849
10	19971020	2.2	43	0.138362	5720.768
11	19971020	3.1	51	0.162510	5740.873
12	19971020	3.4	45	0.105275	5760.157
13	19971020	3.3	70	0.317850	5792.619
14	19971020	2.2	57	0.105558	5816.439
15	19971020	3.1	68	0.145026	5831.346
16	19971020	3.1	49	0.229464	5833.131
17	19971020	1.9	41	0.130308	5824.515
18	19971020	2.0	80	0.510139	5812.560
19	19971020	2.0	65	0.286458	5808.742
20	19971020	2.0	34	0.133602	5830.127
21	19971020	2.1	36	0.054971	5850.172
22	19971020	2.1	36	0.847139	5861.020
23	19971020	3.2	53	0.270029	5846.999
24	19971020	3.2	31	0.330092	5870.256
25	19971020	3.1	50	0.840613	5911.572
26	19971020	3.7	37	0.075209	5893.265
27	19971020	2.9	46	0.064591	5891.721
28	19971020	2.8	89	0.300754	5930.419
29	19971020	5.2	109	0.312916	5953.070
30	19971020	5.5	87	1.175426	5881.651
31	19971020	2.7	63	0.255649	5865.603
32	19971020	2.8	82	0.206075	5896.763
33	19971020	2.9	36	0.069045	5921.528
34	19971020	3.0	33	0.118881	5913.683
35	19971020	3.2	44	0.110103	5897.995
36	19971020	2.8	103	0.346639	5917.173
37	19971020	2.8	75	0.614983	5945.345
38	19971020	3.4	70	0.109070	5958.520
39	19971020	3.9	39	0.611623	5943.173
40	19971020	4.3	61	1.073465	5892.466
41	19971020	3.9	54	0.347963	5842.078
42	19971020	3.8	31	0.212946	5852.117
43	19971020	3.2	41	0.249243	5819.298
44	19971020	3.5	54	1.303582	5850.563
45	19971020	3.1	75	0.419871	5806.409
46	19971021	2.8	96	0.227151	5569.642
47	19971021	2.2	46	0.086160	5627.154
48	19971021	2.2	53	0.088166	5705.489
49	19971021	2.3	42	0.120643	5779.784
50	19971021	2.0	52	0.088886	5825.177
51	19971021	2.3	39	0.187925	5835.227
52	19971021	2.5	51	0.073167	5840.118
53	19971021	2.8	70	0.100871	5861.342

Site_id	Date	Max_pdop	Filt_pos	Std_dev	Gps_height
54	19971021	3.1	38	0.070065	5826.188
55	19971021	3.3	46	0.052101	5810.528
56	19971021	3.2	38	0.203329	5759.726
57	19971021	2.0	56	0.103507	5682.842
58	19971021	2.0	40	0.079564	5670.584
59	19971021	2.1	55	0.096809	5680.872
60	19971021	3.1	68	0.088267	5807.157
61	19971021	1.9	49	0.294062	5759.339
62	19971021	2.0	34	0.085979	5733.097
63	19971021	2.0	32	0.097706	5717.792
64	19971021	2.1	38	0.132695	5660.776
65	19971021	3.2	51	0.233312	5683.492
66	19971021	3.2	48	0.267435	5655.563
67	19971021	3.2	47	0.165259	5632.286
68	19971021	3.1	35	0.076938	5573.484
69	19971021	2.8	41	0.117194	5560.292